

NOAA Technical Memorandum NMFS



**JANUARY 1988**

**HAWAIIAN MONK SEAL POPULATION MONITORING,  
PUP CAPTIVE MAINTENANCE PROGRAM,  
AND INCIDENTAL OBSERVATIONS OF THE  
GREEN TURTLE AT KURE ATOLL, 1985**

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**NOAA-TM-NMFS-SWFC-101**

U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Southwest Fisheries Center

## NOAA Technical Memorandum NMFS

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**NOAA Technical Memorandum NMFS**

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## ABSTRACT

Data on the monk seal, Monachus schauinslandi, were collected at Kure Atoll from 30 January to 23 October 1985. All pups were double-flipper tagged after weaning; the weaned females were maintained in an ocean-beach enclosure until mid-September. The mean count from atoll-wide censuses of monk seals was 24.5, excluding pups of the year, and two tagged turtles, Chelonia mydas, were resighted during the 1985 field season. Pelage bleaching aided in the identification of seals from which a minimum population estimate of 68 seals was derived: 55% adults and 45% nonadults. Of the adult population, 40% were males and 15% females, a 2.6:1 ratio. Five pups, two males and three females, were born from early February to mid-July. All were born at the southwest side of Green Island and survived to the end of the field season. Two deaths and eight injuries were observed. The injuries usually involved the cookiecutter shark, Isistius brasiliensis. Three incidents of entanglement were observed. Two were of seal pups, one male and one female, entangled in fishing line, and the third was a turtle entangled in trawl net. From 12 June to 22 October, 771 samples of fishing debris that could pose a threat of entanglement to wildlife were collected.

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## INTRODUCTION

Kure Atoll (lat. 28°25'N, long. 178°10'W), at the northwestern end of the Hawaiian Archipelago, is one of eight breeding, pupping, and haul-out sites used by the Hawaiian monk seal, Monachus schauinslandi. It also is used for terrestrial basking by the Hawaiian green turtle, Chelonia mydas, which regularly feeds in the atoll waters. Kure Atoll consists of one permanent vegetated island, Green Island, and two weather-dependent sand islets, Shark and Sand Islands. For more descriptive information about the atoll, see Woodward (1972). The U.S. Coast Guard (USCG) operates a loran station on Green Island, and the islands are a Hawaii State seabird sanctuary.

Counts since 1958 indicate that the Hawaiian monk seal population is declining at Kure Atoll and throughout the Northwestern Hawaiian Islands (NWHI) (Johnson et al. 1982). Historical information on seals at Kure Atoll prior to 1957 is essentially limited to scattered accounts of shipwreck victims and the scientific expeditions of the 19th and 20th centuries (Woodward 1972). In 1957 and 1958, Kenyon and Rice (1959) surveyed Kure Atoll. This was followed by other monk seal beach surveys: the Smithsonian Institution from 1963 to 1969 (Wirtz 1968; Woodward 1972), Johnson et al. (1982) from 1977 to 1978, Kenyon (1979,<sup>1</sup> 1980<sup>2</sup>) in 1979-80, and Gilmartin et al. (1986) in 1981. A captive maintenance program for female monk seal pups, initiated in 1981, has been conducted annually in an effort to curb the high mortality rate of weaned female pups (Gilmartin et al. 1986).

Monk seal research was conducted at Kure Atoll in 1985 by the Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service (NMFS), NOAA. The main objectives were to determine monk seal population size and composition through pelage marking and censusing techniques, tag weaned pups, collect weaned female pups for temporary captive maintenance, and quantify and sample debris capable of entangling seals or turtles. The results of this research are presented here.

## METHODS

### Census

Census data were collected at Kure Atoll by a single person, two-person tandem, or two-person split team from 30 January to 22 October 1985. The

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<sup>1</sup>Kenyon, K. W. 1979. Hawaiian monk seal observations at Kure Atoll 10-22 May 1979. Unpubl. rep. for U.S. Fish and Wildlife Service, Seattle, WA 98125, 54 p.

<sup>2</sup>Kenyon, K. W. 1980. Hawaiian monk seal observations at Kure Atoll 17 June-3 July 1980. Unpubl. rep. for U.S. Fish and Wildlife Service, Seattle, WA 98125, 35 p.

two-person tandem censuses were occasionally conducted to ensure consistency in seal size classification, especially if one observer was new to the atoll or census process. Usually, only two observers were present on the atoll at any time (Appendix A). A total of seven NMFS observers recorded census data.

The beaches of all islands at Kure Atoll were divided into sectors (Fig. 1) for the purpose of recording seal location. Green Island consisted of sectors 1-8 and sector 13, which was the ocean-beach enclosure for female pups, who were noted but excluded from census totals. Shark and Sand Islands were each classified as a single sector, sectors 9 and 10, respectively. Sector 11 is a reef known locally as Stark reef, and sector 12 is any area not included in the other sectors. Sectors were unequal in shoreline distance, unvegetated beach area, beach slope, and nearshore habitat. Sectors on Green Island are marked by permanent features, either natural or manmade, and sector divisions are consistent from year to year. Each beach was divided into categories: wet sand, dry sand, and permanent beach above the crest. The location, by sector and beach category, of each seal censused was noted. Not all sectors and categories were always present, especially on the islets where ocean conditions could result in major sand shifts, sometimes causing the islets to disappear. If that was the case or if no seals were present, it was indicated as such in the data.

Green Island was censused on a regular, alternate day basis, except on five occasions when duties related to pup maintenance deemed it necessary to advance the schedule by 1 d. Because monk seals usually haul out in greater numbers in the afternoon (Kenyon and Rice 1959), censuses began between 1143 and 1335 (Hawaii standard time) from 30 January until 22 March, and then at approximately 1300 from 23 March through 22 October. Green Island was always censused first, and if weather and boat conditions allowed, Shark and Sand Islands were censused in that order. Single-person or two-person tandem censuses on Green Island always began at the junction of sectors 1 and 8; however, the direction taken varied. A split team composed of two people went in opposite directions at this junction and usually met at the junction of sectors 3 and 4. The time required for a single census varied with weather, number of seals, and number of observers, all of which were noted. A standard census form (Alcorn and Buelna in prep.<sup>3</sup>) was employed, and general census procedures are detailed by Stone (1984).

Seals were sexed if the ventrum was visible; classified by size; and identified, if possible, by scars, tags, or bleach marks (see Stone (1984) for detailed methodology). Weaned pups identified by tags were always classified as such. The molt status of each seal was recorded as percentage (1-100%) of total body area molted. If the seal's body position prevented the determination of molt status, it was noted on the census form. The only behavior and associations recorded were those occurring as the observer

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<sup>3</sup>Alcorn, D. J., and E. K. Buelna. The Hawaiian monk seal on Laysan Island, 1983. In prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

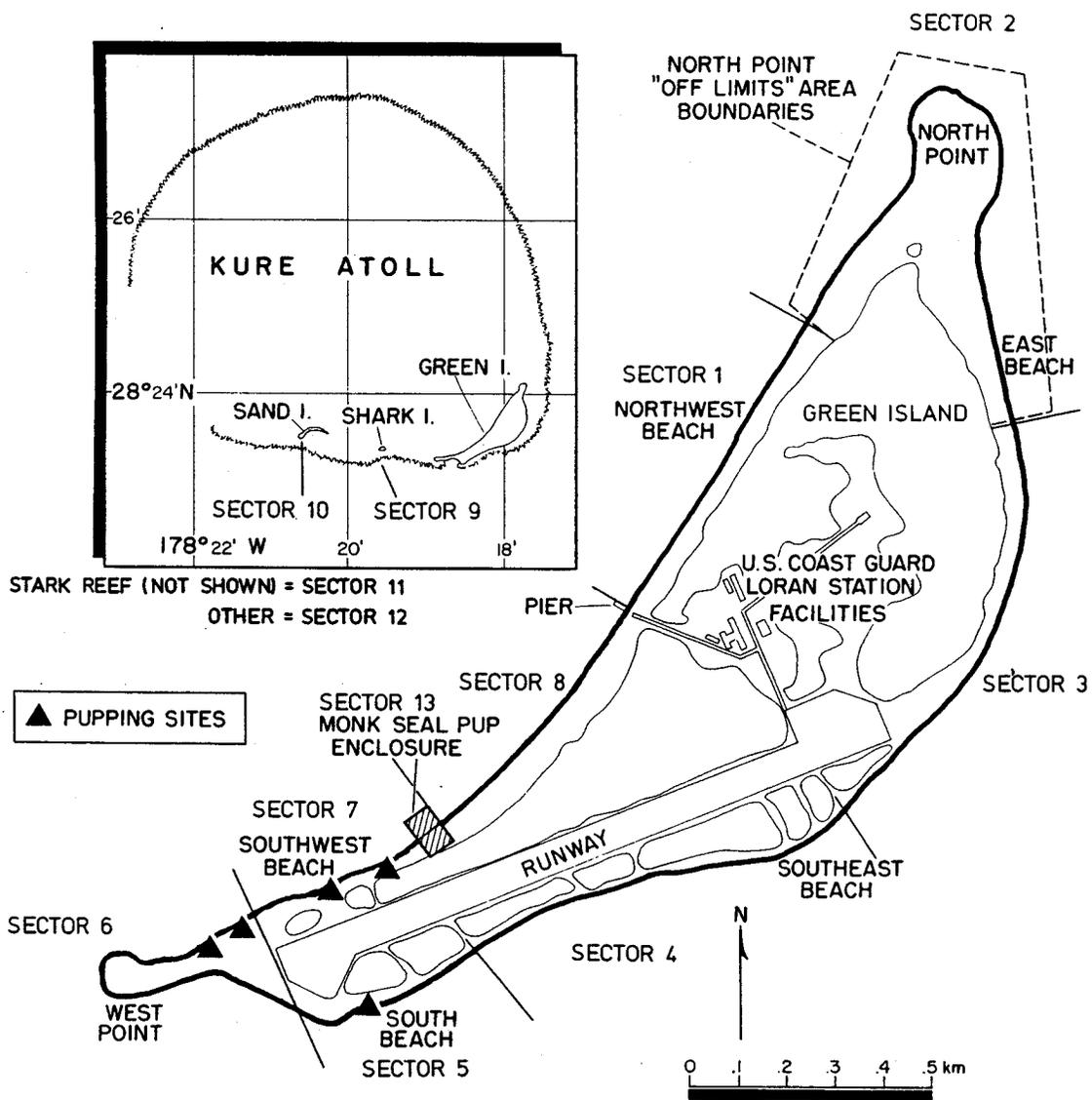


Figure 1.--Map of Kure Atoll, showing the monk seal enclosure, sector division, off limits area, and 1985 pupping sites.

passed by the animal, because lengthy observations would prolong the census and possibly allow for a miscount due to seal movement. Any disturbances related to the observer also were recorded, as were associations between seals and debris capable of entanglement.

Incidental observations of green turtles also were noted: turtle sightings, associations with seals or debris, and, if present, tag numbers.

### Marking

Marking individual, nontagged, nonnursing seals was accomplished by using a commercial hair lightener, as described by Stone (1984) and Johanos et al. (1987). Marking was repeated after a seal molted; a new postmolt bleach number was assigned if initial identification was uncertain. Records of molting seals were kept, as were applications of premolt and postmolt numbers.

### Tagging

All Kure pups were tagged after weaning; no other size classes of seals were tagged. Gray tags were used to indicate Kure Atoll as the seal's birth site. On each tag, a K, indicating the seal was born in 1985, preceded a unique two-digit number. One tag was applied to each hind flipper in the webbing between the fourth and fifth digits. Lost tags were replaced. Further details on tagging procedure and tag description are in Gilmartin et al. (1986).

### Captive Maintenance Program

Newly weaned female pups, in addition to the tagging procedure, were weighed and placed in an ocean-beach enclosure (about 37 x 55 m) located on the southwest side of Green Island (Fig. 1). The ocean-beach enclosure, which was constructed in 1985, included sandy beach and continued into the ocean, surrounding a large, natural coral head. Details on construction of the enclosure can be found in Gilmartin et al. (1986). Three yearling female monk seals translocated from French Frigate Shoals also were placed in the enclosure and maintained from 21 June until their release on 26 and 27 August (details of this work will be presented elsewhere).

To prepare seals to forage independently in the wild, live fish and invertebrates were added to the enclosure at an average of 3.7 kg/d. Feeding was initiated in a new pup by introducing stunned fish until the pup was feeding on its own. All fish were caught in wire mesh fish traps (about 65 x 65 x 90 cm), which were baited, placed at various sites near Green Island, and moved as necessary to obtain maximum yield. Fish catch was weighed on a small spring scale. Species composition of the catch was similar to that in Gilmartin et al. (1986). Fish were not added 10-16 July, but numerous fish were available to the seals in the enclosure.

### Collection of Specimens and Debris

Samples collected in 1985 for laboratory analyses included scats, spews, necropsy samples, and debris capable of entangling seals or turtles. Small samples of fresh scats were collected and placed in 10% formalin or 100% alcohol for future parasitic oocyte analysis. Spews were collected and frozen. For each sample, the collection date, location on the island, and, if known, the size class and sex of the seal were recorded. Results of scat and spew analyses will be presented elsewhere. Data collected on each dead seal recovered included photographs, measurements of length (from nose to tip of tail) and axillary girth, and date last seen alive. Small samples of each major organ were collected and preserved in 10% formalin for pathological analysis. Skulls were flensed and dried. Age estimations were made by using longitudinal sections of the upper canines, following the methods developed by Kenyon and Fiscus (1963); additionally, the sections were etched, following the methods developed by Pierce and Kajimura (1980). Debris capable of entangling seals or turtles was collected from the beaches, reefs, and lagoon from June through October 1985. Data recorded for each piece of debris included the sector and date found, the debris type (e.g., net, rope, or line), material type (e.g., natural fibers, synthetic, or monofilament), total length and width, and stretch mesh of webbing. A sample was retained for laboratory analysis, and the remaining debris was burned so as not to pose a further threat of entanglement.

## RESULTS AND DISCUSSION

### Census Data

Eighty-one whole atoll censuses were conducted on Kure Atoll from 5 February to 22 October 1985 (Appendix B). Counts per island are in Appendixes C-E. Sometimes hazardous weather conditions or an inoperable outboard engine precluded censusing the outer islands. Excluding pups, the total counts averaged 24.5 seals for the whole atoll censuses. The major haul-out island for the seals was Green Island regardless of weather conditions. In October, rough seas washed the islets away and unusually high numbers of seals hauled out on sector 6 of Green Island.

The largest islet, Sand Island (sector 10), was also the most used sector, followed by North Point (sector 2) on Green Island (Appendix F). Both areas are designated as off limits to the USCG; however, a weekly seal census of Green Island was conducted by one or two USCG personnel during 1985. Attempts were made to perform the USCG and NMFS censuses simultaneously to limit use of North Point. The seals' use of Sand Island increased in September, the peak of male molting. During molt, the seals are more alert than usual and, thus, more vulnerable to human disturbance. By hauling out on Sand Island, which is off limits to USCG personnel, the seals can avoid high levels of human disturbance. Birth sites for all 1985 pups were within sectors 5, 6, and 7 (Fig. 1).

### Population Estimate

A minimum population size was estimated by adding the number of tagged seals (27), the number of seals bleached after molting and resighted (30), and the number of easily identified, unbleached seals (11). The total is 68 seals; the composition of which is as follows: adult males, 27; adult females, 10; subadult males, 11; subadult females, 10; juvenile males, 3; juvenile females, 2; weaned males, 2; and weaned females, 3. The population estimate was based on the positive identification of individual seals; therefore, animals not easily identified by scars, tags, or bleach marks were not included in the estimate. The estimated number for the immature size classes is accurate because those seals were all tagged and positively identified; however, there may have been one or two more adult females and a few more adult males than the minimum numbers stated above. Close approach usually resulted in the positive identification of most seals. However, a more precise estimate would have been possible if the bleaching had begun earlier in the season, allowing more time for individual identification, especially of seals that haul out infrequently.

### Tag Resightings

Resightings of Kure pups born and tagged since 1981 are indicated in Table 1. Of the 13 females born and tagged at Kure Atoll since 1981 and included in the captive maintenance program, 12 were still alive at Kure Atoll in 1985. Although males have not been included in the captive maintenance program, 12 of the 15 males born at Kure Atoll since 1981 were still alive in 1985, and 11 were still at the atoll. One male (ID No. K026), born

Table 1.--Annual resightings of Hawaiian monk seal pups born, tagged, and resighted at Kure Atoll, 1981-85 (M = male; F = female).

Year tagged	Pups tagged (No.)		Resightings (No.) by year							
			1982		1983		1984		1985	
	M	F	M	F	M	F	M	F		
1981	4	5	4	4	4	4	3 <sup>a</sup>	4	3 <sup>a</sup>	4
1982	1	3			0	3	0	3	0	3
1983	4	0					3	0	3	0
1984	4	2							3	2
1985	2	3							2	3

<sup>a</sup>One of the male seals born at Kure Atoll in 1981 was sighted at Pearl and Hermes Reef this year.

at Kure Atoll in 1981, moved from the atoll and was sighted at Pearl and Hermes Reef in 1984 (R. Morrow pers. commun.<sup>4</sup>).

Two tagged green turtles were resighted during the 1985 season. One, an adult female (tag No. 6285, 6286, 6287), was found basking on Sand Island on 28 July. Tag records indicate that she was tagged in 1972 at Lisianski Island where she had nested laying 99 eggs. This resighting is the first record of a turtle from any other NWHI resighted at Kure Atoll.

The second resighted turtle (tag No. 2988, 2989, 2990) was a juvenile captured by dip net on 6 August near the shore of the northern part of Green Island. More than 6 yr earlier, on 30 January 1979, it had been tagged in the same general vicinity, where it was found sleeping on the bottom at night (G. Balazs pers. commun.<sup>5</sup>).

### Pup Production and Survival

Five pups were born at Kure Atoll from 3 February to 18 July (Table 2), all at the southwest end of Green Island (Fig. 1). The lactation period ranged from 33 to 41 d and averaged 37 d (Table 2). Weaning was not observed, but daily observations of mother-pup pairs allowed an error of less than 24 h in weaning dates recorded. No pups died, and all pups were resighted throughout the 1985 season. Two of the weaned pups, however, one male and one female, were found entangled with fishing lines (see section on entanglement). Compared to 20-25 yr ago, pup production at Kure Atoll is very low (Kenyon and Rice 1959; Wirtz 1968), probably the result of older adult females dying with little or no recruitment (footnote 2); however, pup survival has now increased, partly because of the pup captive maintenance program. Only one female born at Kure has died or disappeared since initiation of this program in 1981.

Following the construction of the USCG station in 1960, Green Island became less utilized as the major pupping area on the atoll, most likely because of constant human disturbance (Kenyon 1972). Instead of Green Island, most monk seals pupped on the less stable sand islets. Kenyon (footnote 1) suggested that, if the Kure population is to survive, it is probably necessary that Green Island again become the primary pupping site. It is encouraging that, since 1982, all pups except one have been born on Green Island (Table 3). Some restrictions on USCG personnel beach activities at Kure Atoll since the late 1970's may have resulted in reduced disturbance.

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<sup>4</sup>R. Morrow, Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396, pers. commun. November 1985.

<sup>5</sup>G. Balazs, Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396, pers. commun. November 1985.

Table 2.--Summary of Hawaiian monk seal pups born at Green Island, Kure Atoll, 1985. (All actions completed in 1985.)

ID No.	Tag No. <sup>a</sup>		Date		Days nursing	Island tagged	Date tagged	Measurement at tagging (cm)		Mother ID	Capture date	Date weighed	Capture weight (kg)	Release date	Days of captivity
	L	R	Sex	b				Born	Weaned						
K513	K02	K01	M	2/3	3/14	39	Green	3/26	103	133	K186	NA	NA	NA	NA
K514	K04	K03	M	2/20	3/25	33	Green	3/26	103	130	K266	NA	NA	NA	NA
K515	K00	K06	F	4/8	5/13	35	Green	5/13	112	130	K068	5/13	78	9/20	130
K516	K07	K08	F	4/20	5/31	41	Green	6/1	120	135	K009	6/1	107	9/20	111
K517	K10	K11	F	7/18	8/27	40	Green	8/28	106	123	K070	8/28	68	9/20	23

<sup>a</sup>L = left hind flipper; R = right hind flipper.

<sup>b</sup>F = female; M = male.

Table 3.--Number and location of Hawaiian monk seals born at Kure Atoll, 1976-85.

Year	Total No. of pups born	No. pups born by island		Reference
		Green Island	Sand Island	
1976	9	4	5	Johnson et al. 1982 <sup>a</sup>
1977	10	4	6	Johnson et al. 1982 <sup>a</sup>
1978	10	4	6	Johnson et al. 1982 <sup>a</sup>
1979	10	3	7	Johnson et al. 1982 <sup>a</sup>
1980	6 <sup>b</sup>	--	--	Kenyon 1980 <sup>c</sup>
1981	10	6	4	Gilmartin et al. 1986
1982	5	5	0	Bowlby et al. in prep. <sup>d</sup>
1983	4 <sup>e</sup>	3	0	Bowlby et al. in prep. <sup>d</sup>
1984	6	5	1	Watson pers. commun. <sup>f</sup>
1985	5	5	0	This study

<sup>a</sup>Johnson, A. M., M. Rauzon, J. Ruehle, and K. Kenyon. 1980. Hawaiian monk seals: Kure Atoll studies, 1976-79. Unpubl. rep. for U.S. Fish and Wildlife Service, Anchorage, AK 99501, 13 p.

<sup>b</sup>Minimum, not total, number of pups born. Location of births is unknown.

<sup>c</sup>Kenyon, K. W. 1980. Hawaiian monk seal observations at Kure Atoll 17 June-3 July 1980. Unpubl. rep. for U.S. Fish and Wildlife Service, Seattle, WA 98125, 35 p.

<sup>d</sup>C. E. Bowlby, P. D. Scoggins, R. T. Watson, and M. L. Reddy. Hawaiian monk seal, Monachus schauinslandi, at Kure Atoll, 1982 and 1983. In prep. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

<sup>e</sup>Last pup born after NMFS personnel left the atoll; location of birth is unknown.

<sup>f</sup>R. Watson. Southwest Fisheries Center Honolulu Laboratory, National Marine Fisheries Service, NOAA, 2570 Dole Street, Honolulu, HI 96822-2396, pers. commun. November 1985.

### Captive Pup Maintenance

All weaned female pups were successfully captured and placed in the fenced enclosure on the southwest side of Green Island for captive maintenance. Data collected at the time of capture are in Table 2. See Appendix G for an itinerary of the captive maintenance work at Kure Atoll in 1985.

Because fish were transported from collection sites around the lagoon to the enclosure in a Boston Whaler, the seals soon learned to associate the sound of the engine with their daily fish. Such an association could be detrimental to the seals in the wild. To try to discourage this association, no fish were added to the enclosure between 10 and 16 July, and NMFS and USCG personnel avoided the enclosure area. This effort failed, however. The yearlings from French Frigate Shoals sometimes approached the boat in the lagoon when they heard the engine, even after their release. Female pups from previous years also approached the boat at various times during 1985. Methods to avoid development of this association should be explored in future years. One alternative is to build a small adjoining holding pen in which the live reef fish can be retained. Dipnets could then be used to transfer fish to the seal enclosure when the pups are asleep on the beach.

Two of the Kure pups were already feeding regularly at the time the yearlings from French Frigate Shoals were introduced to the enclosure. Within a few weeks, observations revealed that the pups' fish were being stolen by the yearlings. One of the Kure pups (ID No. K515) began to visibly lose weight, and avoided the others while fish were being introduced into the pen. At this time, it was decided to release the yearlings. On 26 August and again on 27 August, a hole was cut in the fencing on the beach where the yearlings normally hauled out, and the area was monitored to prevent the Kure pups from escaping. Within 2 h, the yearling seals eventually found their way out of the enclosure. Within a day of the release, the pups remaining in the enclosure began eating more aggressively.

On the night of 19 September, 3 d before the planned release of the three Kure-born seal pups in the enclosure, a storm and resultant rough water weakened the enclosure. On the morning of 20 September, the bottom of the fencing on the oceanside of the enclosure had begun to break away from the poles, and one pup (ID No. K515) had escaped, presumably by swimming under the fence. For the safety of the animals, immediate disassembly of the enclosure was begun; during this time, a second pup (ID No. K516) was seen going under the fence. An opening was cut to release the last pup (ID No. K517). The entire oceanside of the enclosure was then disassembled to prevent any possible injury or entrapment of seals. The remainder of the pen was dismantled after the storm passed. All three pups and three yearlings were resighted through the end of the 1985 season.

### Deaths and Injuries

Necropsies were performed on two seals that died and were recovered during the field season (Table 4; Appendix H). A third seal disappeared and presumably died (Table 5); the details of that incident can be found below.

Table 4.--Hawaiian monk seal deaths at Kure Atoll, 1985.

Necropsy No.	ID	Date	Size <sup>a</sup>	Sex <sup>b</sup>	Cause of death
01MSK85	Not determined	2/23	A	M	Unknown--see Appendix H
02MSK85	245	4/8	J	M	Unknown--see Appendix H

<sup>a</sup>A = adult; J = juvenile.

<sup>b</sup>M = male.

Table 5.--Hawaiian monk seal injuries at Kure Atoll, 1985.

Date	Size <sup>a</sup>	Sex <sup>b</sup>	ID No.	Description of injury	Probable cause <sup>c</sup>
1/31	A	M	?	Round dorsal wound	<u>Isistius brasiliensis</u>
2/13	A	M	K180	Round chest wound	<u>I. brasiliensis</u>
2/27	A	U	?	Two round dorsal wounds	<u>I. brasiliensis</u>
5/20	A	F	?	Ventral round wound above right front flipper	<u>I. brasiliensis</u>
6/8	A	M	?	Seal <sup>d</sup> was extremely emaciated. One large dorsal wound, ca. 25 cm long and 7.5 cm deep, and several smaller areas of torn dorsal flesh	Adult male inflicted
9/16	S	F	K134	Round dorsal wound	<u>I. brasiliensis</u>
9/21	A	M	K059	Two round wounds, left shoulder	<u>I. brasiliensis</u>
10/20	A	F	?	Large round wound, right shoulder	<u>I. brasiliensis</u>

<sup>a</sup>A = adult; S = subadult.

<sup>b</sup>F = female, M = male, and U = sex unknown.

<sup>c</sup>Isistius brasiliensis is also called the cookiecutter shark because of its propensity of leaving a mark similar to a biscuit cutter. The resultant wound may be up to 5.0 cm or more in depth (Fig. 2).

<sup>d</sup>Disappeared, presumed dead.

Most injuries observed in 1985 were probably inflicted by Isistius brasiliensis, the cookiecutter shark (Table 5), whose bite leaves circular wounds on the seal (Fig. 2; Jones 1971). Only one injury not involving this shark was noted.

On 7 June at approximately 1600, two adult seals were found in a shallow reef area in the lagoon. One seal was severely emaciated, the other (a male) lay nearby. They were observed for 45 min in an unsuccessful attempt to determine the sex of the emaciated seal. The emaciated seal had severe dorsal wounds, the largest approximately 25 cm long and 7.5 cm deep. The wounds appeared to have been inflicted by another seal, rather than a shark. On 8 June, the site was revisited at 1000. Both seals were still at the site, and the sex of the injured seal was determined to be a male. When the site was revisited on 9 June, both seals had disappeared. The injured seal was never resighted and presumably died.

### Entanglement

#### Debris

From 12 June to 22 October, 771 samples of fishing debris that could pose an entanglement problem to monk seals and green turtles were collected and sampled at Kure Atoll. The webbing and net samples were included with those from other NWHI areas (French Frigate Shoals, Laysan Island, Lisianski Island, and Pearl and Hermes Reef) for the years 1982 through 1986, and where possible, they were collectively analyzed for fishery of origin. (Henderson et al. 1987<sup>6</sup>). Lines and other debris are being classified; these data will be presented elsewhere.

#### Entanglement Cases

Three incidents of entanglement in fishing debris were observed. Two involved weaned pups (Table 6), and one involved an adult green turtle. The two pups were entangled in monofilament fishing line, similar to the type used for recreational fishing at Kure Atoll. Descriptions of the three cases follow.

Case 1. A male pup (ID No. K513) weaned on 14 March 1985 was found on 4 May on the northwestern point of Green Island with an 81 cm length of 34 kg (75 lb) test fishing line (Fig. 3a) tightly wrapped around his body, just under the foreflippers. The pup was restrained and the line was cut. There were no cuts due to the line, and the pup appeared to be in good

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<sup>6</sup>Henderson, J. R., S. L. Austin, and M. B. Pillos. 1987. Summary of webbing and net fragments found on Northwestern Hawaiian Islands beaches, 1982-86. Southwest Fisheries Center Honolulu Laboratory, Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96822-2396. Southwest Fish. Cent. Admin. Rep. H-87-11, 15 p.

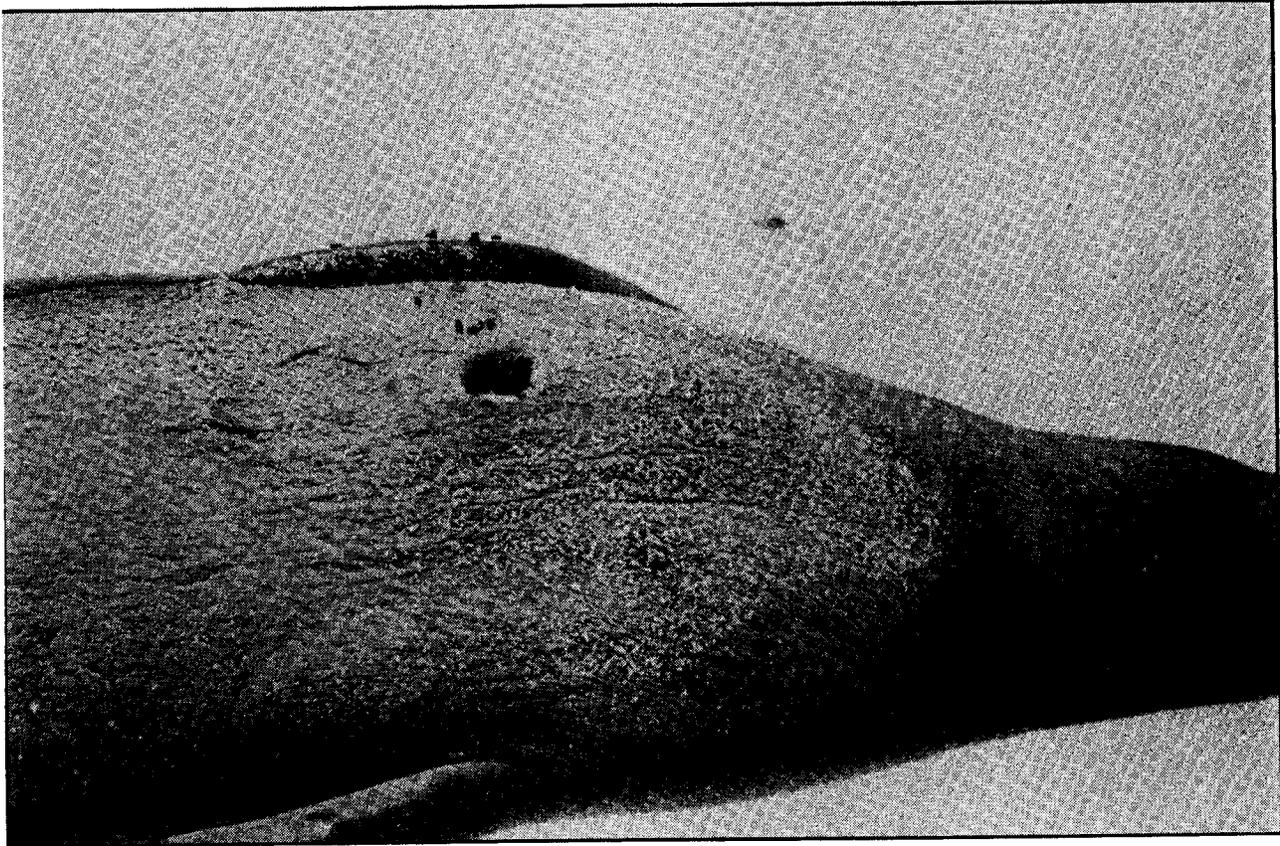


Figure 2.--Seal with round chest wound, which due to its depth and configuration, was probably inflicted by the cookiecutter shark or Isistius brasiliensis. These wounds and their scars are found often on monk seals throughout the Northwestern Hawaiian Islands, and are used in the identification of individual seals.

Table 6.--Hawaiian monk seal entanglement in debris by sector on Green Island, Kure Atoll, 1985.

Date	Sector	Location of seal	Seal			Type of debris	Part of body entangled	Mobility <sup>c</sup>
			Size <sup>a</sup>	Sex <sup>b</sup>	ID			
5/3	2	Land	W	M	K513	Monofilament line	Around chest	MO
9/22	6	Water	W	F	K517	Hook, leader, and monofilament line	Mouth and hind flippers <sup>d</sup>	MR

<sup>a</sup>W = weaned pup.

<sup>b</sup>F = female; M = male.

<sup>c</sup>MO = mobile; MR = movement restricted.

<sup>d</sup>The hook was caught in the seal's mouth, while the monofilament under tension was wrapped around the hind flippers.

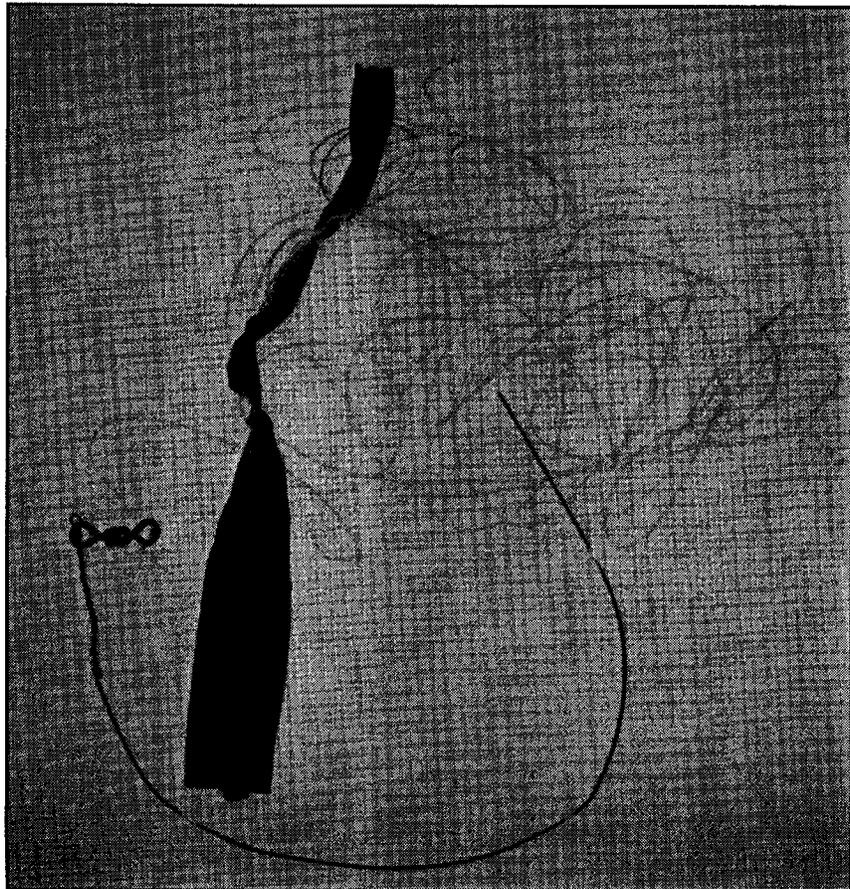
health. He had been sighted 2 d earlier without the line; therefore, his entanglement was recent. The day following the entanglement, he was resighted, and no effects due to the incident were obvious.

Case 2. A female pup (ID No. K517), who had been part of the captive maintenance program and had been released on 20 September, was found on 22 September on the west point of Green Island, with a fishhook and attached 23 kg (50 lb) test monofilament line in her mouth (Fig. 3b). After tools were obtained to cut the hook, the pup was found in the water with the hook still in her mouth, the line wrapped around her rear flippers, and her body flopping as she tried to swim. Two adult seals were as close as 1 m; their sex was undetermined, and no aggression was observed. The pup swam to deeper water, and attempts to corral her to shore with the Boston Whaler were unsuccessful. Within an hour, the pup came ashore, and the hook, no longer in her mouth, was hooked into her chest. She was restrained, and the hook was cut out. The pup suffered no apparent serious injury and was resighted throughout the remainder of the season.

Case 3. On 9 June 1985, a large turtle found in a shallow reef area at Kure Atoll had trawl net wrapped around its neck and left front flipper, and the net was firmly caught in the coral. The turtle was estimated to be approximately 135 kg with a 120 cm straight length carapace. He was lifted into a Boston Whaler with the help of USCG personnel in the area. The net was cut, and the turtle was examined for cuts, photographed, and released. Except for a few small cuts, the turtle appeared to be in good health.



Figure 3a.--Fishing line from entanglement Case 1.



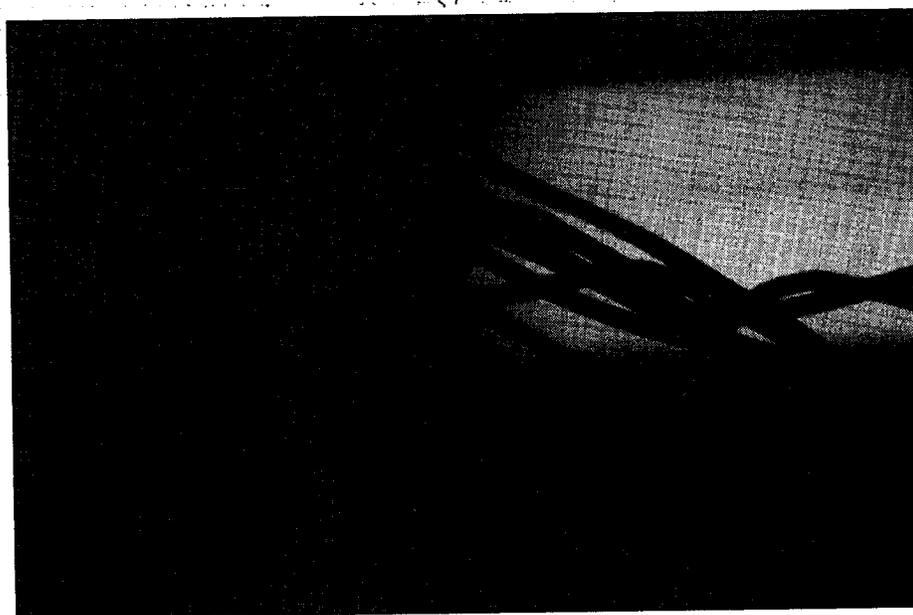
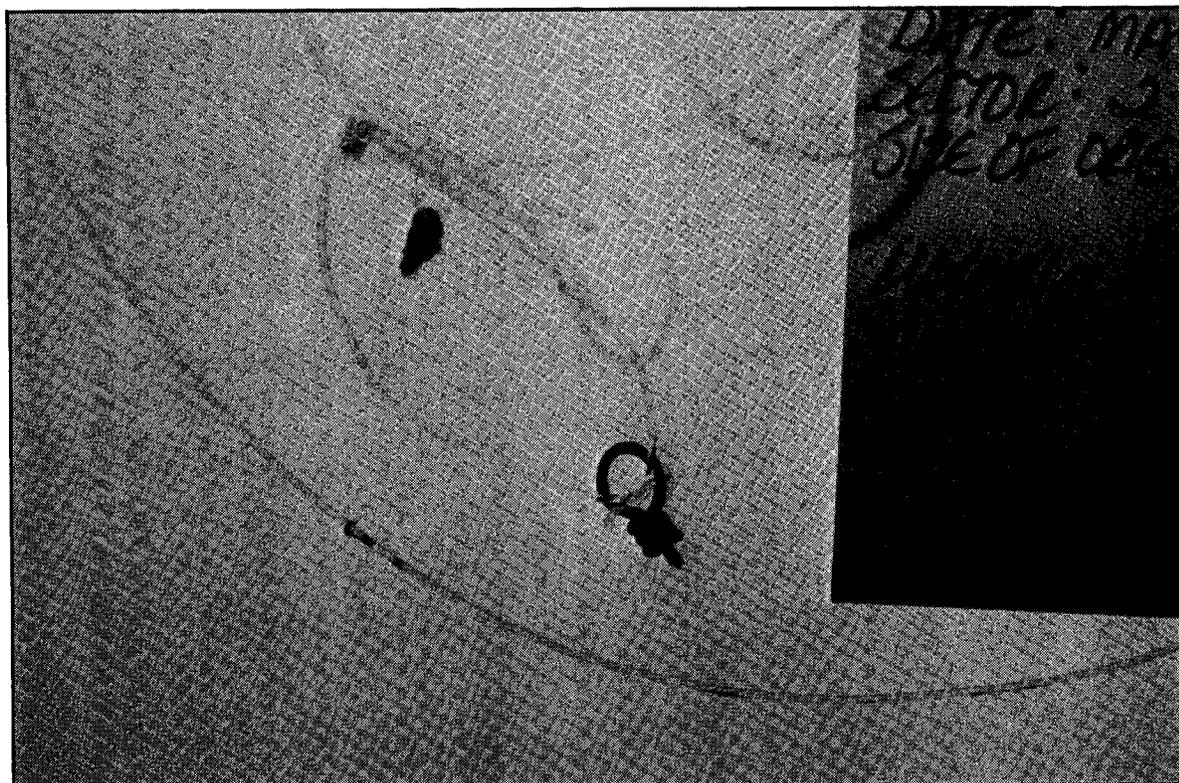


Figure 3b.--Fishing line from entanglement Case 2.

## ACKNOWLEDGMENTS

We wish to thank the USCG personnel at Kure Atoll for their help, especially Patrick Burniston, Stan Jones, and "Poggi." A special note of thanks is extended to Capt. Hsu and the flight crews at Barbers Point, Honolulu, for regular delivery of supplies and exchange of personnel to the atoll. Also, we thank Patricia L. Pagel for her volunteer efforts.

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# **APPENDIXES**

## Appendix A.--Itinerary for the 1985 Kure Atoll fieldwork.

Date	Event
1/29	M. L. Reddy, R. L. Westlake, S. L. Austin, and R. G. Forsyth arrive at Kure Atoll via U.S. Coast Guard C-130. Set up camp and begin observations of monk seals and pup captive maintenance work under State of Hawaii Scientific Collecting Permit (SCP) 85-28 and Marine Mammal Protection Act/Endangered Species Act Permit Nos. 413 and 372.
1/31	Westlake, Austin, and Forsyth return to Honolulu. Reddy remains to continue observations.
3/11	R. J. Morrow and C. A. Griffith arrive at Kure Atoll. Construction of ocean-beach enclosure for captive maintenance commences.
3/27	Morrow returns to Honolulu. Reddy and Griffith continue research at Kure.
4/12	Reddy returns to Honolulu. Griffith remains to continue observations.
4/23	Reddy returns to Kure Atoll.
7/19	Reddy returns to Honolulu. J. R. Henderson replaces Reddy, and L. D. Banish, D.V.M., arrives to take blood and culture samples from pups and to later replace Griffith.
7/29	Reddy returns to Kure.
8/2	Griffith and Henderson return to Honolulu.
8/8	D. J. Alcorn arrives and replaces Banish, who returns to Honolulu.
8/19	P. M. Pagel arrives to replace Alcorn.
8/21	Alcorn returns to Honolulu.
9/5	Austin arrives to replace Pagel, and Banish returns to take blood and culture samples from pups.
9/6	Pagel and Banish return to Honolulu.
9/24	Austin returns to Honolulu; Reddy remains to complete project work at Kure Atoll.
10/23	Kure Atoll field camp is disbanded. Reddy terminates project work at Kure Atoll. Returns to Honolulu.

Appendix B.--Number of Hawaiian monk seals, by age class and sex, counted on whole atoll censuses conducted at Kure Atoll, 1985. (M = male, F = female, and ? = unknown.)

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non-pup	Pup	Grand
2/5	9	3	7	1	4	5	2	1	2	1	0	0	34	1	35
2/17	6	2	4	4	3	3	2	0	1	1	0	0	25	1	26
2/23	10	4	6	5	3	2	2	1	1	2	0	0	34	2	36
3/13	11	2	8	2	2	2	3	1	2	2	0	0	33	2	35
3/17	7	5	5	4	1	6	2	0	3	2	0	0	33	2	35
3/21	3	3	3	5	3	1	2	1	0	2	0	0	21	2	23
4/2	8	1	3	2	1	4	1	0	0	2	0	0	20	2	22
4/8	6	3	5	2	2	1	4	0	0	1	1	0	23	2	25
4/10	10	2	4	0	0	3	1	2	0	1	1	0	22	2	24
4/30	11	5	5	3	3	1	1	0	0	2	2	0	29	4	33
5/22	8	2	4	4	2	3	2	1	0	2	0	0	26	2	28
5/24	12	3	4	2	2	2	2	1	0	0	1	0	28	1	29
5/26	11	4	6	4	1	3	0	0	1	1	0	0	30	1	31
5/28	6	2	2	5	0	3	1	0	0	1	1	0	19	2	21
5/30	5	3	3	1	3	1	0	0	2	2	1	0	18	3	21
6/1	10	1	1	4	1	4	0	0	0	2	1	0	21	3	24
6/3	7	2	2	2	3	2	2	2	0	0	0	0	22	0	22
6/5	11	0	0	1	4	6	2	0	0	2	2	0	24	4	28
6/7	8	2	1	3	5	1	0	0	0	0	2	0	20	2	22
6/9	7	2	0	3	4	2	1	1	0	2	2	0	20	4	24
6/13	7	3	0	2	3	5	1	1	0	1	1	0	22	2	24
6/17	3	2	1	3	3	3	1	1	0	0	0	0	17	0	17
6/19	7	2	0	1	1	1	1	0	0	1	1	0	13	2	15
6/22	8	2	1	3	7	0	1	0	0	1	2	0	22	3	25
6/24	10	1	2	2	5	2	1	0	0	1	1	0	23	2	25
6/26	10	2	3	5	3	2	0	0	0	2	2	0	25	4	29
6/28	6	1	2	2	1	4	0	1	0	1	1	0	17	2	19
6/30	5	1	1	3	4	2	1	1	0	1	2	0	18	3	21
7/2	10	1	1	3	5	0	2	1	0	1	2	0	23	3	26
7/4	9	2	0	6	6	3	0	0	0	1	2	0	26	3	29
7/6	12	2	3	5	1	5	1	1	1	2	1	0	31	3	34
7/8	9	3	4	4	5	1	0	0	0	1	2	0	26	3	29
7/12	8	1	1	5	6	3	0	0	0	2	1	0	24	3	27
7/14	8	5	1	2	4	3	1	0	0	0	1	0	24	1	25
7/16	8	2	0	5	3	1	1	0	0	2	1	0	20	3	23
7/18	4	2	1	2	3	2	2	0	0	2	2	0	16	4	20
7/20	4	1	0	1	2	3	1	1	0	1	2	0	13	3	16
7/22	5	1	3	4	4	0	0	0	1	2	3	0	18	5	23
7/24	12	3	0	5	6	1	0	1	0	2	3	0	28	5	33
7/26	9	2	3	3	2	0	0	1	0	2	2	0	20	4	24
7/28	13	1	2	4	3	2	0	1	0	2	2	0	26	4	30
7/30	9	3	2	3	1	3	0	1	0	2	2	0	22	4	26

## Appendix B.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non-pup	Pup	Grand
8/1	8	4	1	3	1	2	1	0	1	1	0	0	21	1	22
8/3	10	1	2	2	1	2	2	1	0	1	0	0	21	1	22
8/5	12	4	1	3	1	1	1	0	0	1	2	0	23	3	26
8/7	8	3	3	4	1	1	1	1	0	1	3	0	22	4	26
8/9	11	2	1	2	1	2	1	1	0	2	3	0	21	5	26
8/13	4	2	0	3	1	3	1	1	0	2	2	0	15	4	19
8/15	8	0	1	2	1	0	1	1	0	1	2	0	14	3	17
8/17	11	3	1	4	1	0	0	1	0	1	2	0	21	3	24
8/18	10	2	2	4	0	0	1	1	0	1	1	0	20	2	22
8/20	12	0	0	2	1	0	0	1	0	1	2	0	16	3	19
8/24	13	1	2	4	0	0	1	1	0	1	1	0	22	2	24
8/27	7	2	3	2	4	0	0	1	0	1	3	0	19	4	23
8/29	8	1	4	3	1	1	1	1	0	2	3	0	20	5	25
8/31	8	3	2	2	0	2	0	1	0	1	1	0	18	2	20
9/2	13	0	7	4	2	0	1	1	0	2	1	0	28	3	31
9/4	15	2	5	0	4	0	1	1	0	1	2	0	28	3	31
9/6	17	1	1	3	3	0	1	0	0	1	1	0	26	2	28
9/8	16	2	4	1	2	2	1	1	0	2	1	0	29	3	32
9/10	12	1	3	5	2	1	1	1	0	1	0	0	26	1	27
9/12	15	1	2	6	1	2	0	1	0	1	0	0	28	1	29
9/14	12	1	3	4	2	1	0	1	0	1	1	0	24	2	26
9/16	17	0	0	8	3	0	1	0	0	2	1	0	29	3	32
9/18	13	2	4	5	2	2	0	0	0	2	1	0	28	3	31
9/21	16	1	6	8	1	3	1	1	1	2	0	1	38	3	41
9/24	11	1	11	5	3	2	1	2	1	2	0	0	37	2	39
9/26	7	2	7	2	3	3	0	1	0	1	2	0	25	3	28
9/28	11	1	6	5	4	6	1	1	0	2	2	0	35	4	39
9/30	14	3	5	4	2	1	1	1	0	1	3	0	31	4	35
10/2	13	0	0	2	2	1	1	0	0	1	2	0	19	3	22
10/4	13	1	1	3	1	0	1	0	0	2	1	0	20	3	23
10/6	17	2	1	4	4	2	1	1	0	2	2	0	32	4	36
10/8	14	2	1	9	3	1	1	0	0	1	2	0	31	3	34
10/10	10	4	4	2	5	0	1	2	0	2	1	0	28	3	31
10/12	7	0	3	2	4	3	1	1	0	1	0	1	21	2	23
10/14	15	2	2	4	7	1	1	1	0	2	2	1	33	5	38
10/16	9	1	4	4	4	2	1	1	0	1	0	0	31 <sup>a</sup>	1	32
10/18	11	2	1	7	6	4	0	1	0	2	3	0	32	5	37
10/20	12	6	1	8	5	2	0	2	0	2	1	1	36	4	40
10/22	7	2	1	6	6	3	0	0	0	0	0	0	38 <sup>a</sup>	0	38

<sup>a</sup>Total includes some seals that were not placed in any size class.

Appendix C.--Number of Hawaiian monk seals, by age class and sex, counted on censuses conducted at Green Island, Kure Atoll, 1985. (M = male, F = female, and ? = unknown.)

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non-pup	Pup	Grand
	1/30	10	3	2	4	2	1	2	3	0	0	0	0	27	0
2/1	8	1	2	1	4	1	4	1	1	0	0	0	23	0	23
2/3	6	3	2	1	3	1	2	0	1	1	0	0	19	1	20
2/5	8	3	4	0	2	4	2	1	1	1	0	0	25	1	26
2/7	9	4	5	2	1	3	3	1	0	1	0	0	28	1	29
2/9	8	4	1	1	2	2	2	0	0	1	0	0	20	1	21
2/11	5	4	2	2	2	4	1	2	0	1	0	0	22	1	23
2/13	11	3	2	2	1	2	1	1	0	1	0	0	23	1	24
2/15	10	3	4	3	3	3	2	1	1	1	0	0	30	1	31
2/17	5	2	2	3	2	2	2	0	1	1	0	0	19	1	20
2/19	7	5	2	4	3	3	3	1	0	1	0	0	28	1	29
2/21	15	6	7	5	2	1	1	1	0	2	0	0	38	2	40
2/23	6	3	2	2	1	0	0	1	0	2	0	0	15	2	17
2/25	8	2	2	2	0	0	1	0	0	2	0	0	15	2	17
2/27	7	1	4	2	0	2	2	0	0	1	0	0	18	1	19
3/1	7	0	2	1	3	1	1	1	0	0	0	0	16	0	16
3/3	8	4	6	1	2	1	2	2	0	2	0	0	26	2	28
3/5	8	3	2	1	1	2	2	0	0	2	0	0	19	2	21
3/7	4	2	2	2	0	1	1	2	1	1	0	0	15	1	16
3/9	6	2	3	1	2	1	2	0	0	1	0	0	17	1	18
3/11	6	6	3	1	0	1	2	1	0	2	0	0	20	2	22
3/13	10	2	4	0	1	0	2	0	0	2	0	0	19	2	21
3/15	9	3	1	1	2	0	2	0	0	2	0	0	18	2	20
3/17	3	4	1	0	0	0	1	0	1	2	0	0	10	2	12
3/19	5	2	7	0	1	2	1	0	1	2	0	0	19	2	21
3/21	1	2	2	1	1	0	2	1	0	2	0	0	10	2	12
3/23	4	3	2	3	1	2	2	0	0	1	0	0	17	1	18
3/25	2	0	3	1	2	2	2	1	0	2	0	0	13	2	15
3/27	8	3	3	0	4	4	2	2	1	1	0	0	27	1	28
3/29	7	2	2	2	1	3	2	1	0	1	0	0	20	1	21
3/31	6	1	2	0	2	1	0	0	0	2	0	0	12	2	14
4/2	5	1	2	1	0	1	0	0	0	2	0	0	10	2	12
4/4	3	1	7	0	1	2	0	0	0	2	0	0	14	2	16
4/6	5	4	6	2	0	1	2	0	1	1	0	0	21	1	22
4/8	2	1	3	1	1	0	2	0	0	1	1	0	10	2	12
4/10	7	2	2	0	0	2	1	2	0	1	1	0	16	2	18
4/12	3	2	3	1	0	0	1	0	0	2	1	0	10	3	13
4/14	2	3	1	0	1	1	0	1	0	2	1	0	9	3	12
4/16	4	2	0	0	0	1	2	1	1	1	1	0	11	2	13
4/18	2	4	2	1	0	0	0	1	1	1	1	0	11	2	13
4/20	3	3	2	0	0	1	1	0	1	0	2	0	11	2	13
4/22	4	3	1	0	2	2	3	0	0	2	2	0	15	4	19

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non-pup	Pup	Grand
4/24	6	4	3	1	0	3	1	0	1	2	2	0	19	4	23
4/26	12	5	2	0	2	2	2	1	0	2	2	0	26	4	30
4/28	5	4	5	0	1	6	1	2	0	1	1	0	24	2	26
4/30	5	5	5	2	2	1	1	0	0	2	2	0	21	4	25
5/2	4	3	5	0	1	0	2	2	0	2	2	0	17	4	21
5/4	5	3	3	1	1	1	2	1	0	1	1	0	17	2	19
5/6	7	3	3	0	1	0	1	1	0	2	1	0	16	3	19
5/8	3	5	2	0	2	0	2	1	0	2	2	0	15	4	19
5/10	6	4	2	1	1	0	0	1	0	1	2	0	15	3	18
5/12	1	4	4	0	1	0	1	0	0	1	2	0	11	3	14
5/14	9	3	2	0	1	0	1	1	0	2	1	0	17	3	20
5/16	6	4	2	0	2	0	0	0	1	2	1	0	15	3	18
5/18	3	2	7	2	0	1	1	1	0	2	0	0	17	2	19
5/20	9	6	2	1	2	1	0	1	0	1	1	0	22	2	24
5/22	5	1	3	1	1	0	2	1	0	2	0	0	14	2	16
5/24	7	1	3	1	2	0	2	1	0	0	1	0	17	1	18
5/26	9	2	4	2	1	2	0	0	1	1	0	0	21	1	22
5/28	3	2	1	1	0	1	0	0	0	1	1	0	8	2	10
5/30	3	2	0	1	2	0	0	0	0	2	1	0	8	3	11
6/1	3	0	1	3	1	0	0	0	0	2	1	0	8	3	11
6/3	3	2	0	0	0	1	1	2	0	0	0	0	9	0	9
6/5	6	0	0	1	3	2	0	0	0	2	2	0	12	4	16
6/7	5	1	0	0	3	1	0	0	0	0	2	0	10	2	12
6/9	4	1	0	1	2	1	0	1	0	2	2	0	10	4	14
6/11	3	1	0	1	2	0	0	0	0	2	2	0	7	4	11
6/13	4	2	0	1	3	2	1	1	0	1	1	0	14	2	16
6/15	5	3	2	1	1	1	2	0	0	1	0	0	15	1	16
6/17	1	2	0	0	1	2	1	1	0	0	0	0	8	0	8
6/19	4	2	0	0	1	0	1	0	0	1	1	0	8	2	10
6/20	6	1	4	2	2	1	0	0	0	1	1	0	16	2	18
6/22	4	1	0	1	6	0	1	0	0	1	2	0	13	3	16
6/24	6	1	2	0	2	2	0	0	0	1	1	0	13	2	15
6/26	8	2	3	2	3	1	0	0	0	2	2	0	19	4	23
6/28	4	1	0	2	0	2	0	1	0	1	1	0	10	2	12
6/30	2	1	1	1	3	1	1	1	0	1	2	0	11	3	14
7/2	8	1	1	0	4	0	1	1	0	1	2	0	16	3	19
7/4	6	2	0	2	6	2	0	0	0	1	2	0	18	3	21
7/6	8	2	3	1	1	4	1	1	1	2	1	0	22	3	25
7/8	6	2	4	3	2	0	0	0	0	1	2	0	17	3	20
7/10	5	3	2	3	5	0	0	0	0	2	2	0	18	4	22
7/12	5	1	1	1	4	2	0	0	0	2	1	0	14	3	17
7/14	4	4	0	1	3	1	0	0	0	0	1	0	13	1	14
7/16	6	2	0	0	2	1	0	0	0	2	1	0	11	3	14
7/18	2	2	1	0	1	0	1	0	0	2	2	0	7	4	11

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non-	Pup	Grand
													pup		
7/20	1	1	0	0	0	0	0	1	0	1	2	0	3	3	6
7/22	4	1	2	0	2	0	0	0	1	2	3	0	10	5	15
7/24	9	2	0	2	4	1	0	0	0	2	3	0	18	5	23
7/26	8	2	2	1	0	0	0	1	0	2	2	0	14	4	18
7/28	8	1	2	1	3	0	0	1	0	2	2	0	16	4	20
7/30	5	3	2	1	0	0	0	0	0	2	2	0	11	4	15
8/1	5	2	0	1	0	0	1	0	1	1	0	0	10	1	11
8/3	7	0	1	0	0	0	0	1	0	1	0	0	9	1	10
8/5	7	2	1	0	1	0	1	0	0	1	2	0	12	3	15
8/7	7	1	2	1	1	1	1	0	0	1	3	0	14	4	18
8/9	7	1	1	0	0	1	1	1	0	2	3	0	12	5	17
8/11	6	0	2	0	4	2	1	0	0	1	1	0	15	2	17
8/13	1	2	0	1	0	1	1	0	0	2	2	0	6	4	10
8/15	4	0	1	1	1	0	1	0	0	1	2	0	8	3	11
8/17	7	3	1	3	1	0	0	0	0	1	2	0	15	3	18
8/18	7	2	2	2	0	0	1	0	0	1	1	0	14	2	16
8/20	8	0	0	1	1	0	0	0	0	1	2	0	10	3	13
8/22	5	0	0	1	0	0	1	0	0	1	2	0	7	3	10
8/24	6	1	2	1	0	0	1	0	0	1	1	0	11	2	13
8/26	6	2	2	0	0	2	0	0	0	1	3	0	12	4	16
8/27	3	0	0	0	4	0	0	0	0	1	3	0	7	4	11
8/29	4	1	2	0	1	0	1	0	0	2	3	0	9	5	14
8/31	2	3	2	0	0	0	0	0	0	1	1	0	7	2	9
9/2	11	0	7	1	1	0	1	1	0	2	1	0	22	3	25
9/4	11	2	2	0	3	0	1	0	0	1	2	0	19	3	22
9/6	11	1	1	0	2	0	1	0	0	1	1	0	16	2	18
9/8	12	1	3	0	2	0	1	0	0	2	1	0	19	3	22
9/10	9	1	2	2	2	0	1	1	0	1	0	0	18	1	19
9/12	8	0	1	2	1	0	0	0	0	1	0	0	12	1	13
9/14	6	1	2	3	1	0	0	0	0	1	1	0	13	2	15
9/16	12	0	0	3	1	0	0	0	0	2	1	0	16	3	19
9/18	9	2	3	3	1	1	0	0	0	2	1	0	19	3	22
9/21	12	0	2	5	1	0	1	1	1	2	0	1	23	3	26
9/22	8	1	3	2	3	1	1	1	0	1	1	0	20	2	22
9/24	8	0	5	4	2	0	1	2	0	2	0	0	22	2	24
9/26	5	1	4	0	2	2	0	0	0	1	2	0	14	3	17
9/28	7	1	3	1	3	5	0	0	0	2	2	0	20	4	24
9/30	5	1	2	1	2	1	0	0	0	1	1	0	12	2	14
10/2	13	0	0	2	2	1	1	0	0	1	2	0	19	3	22
10/4	13	1	1	3	1	0	1	0	0	2	1	0	20	3	23
10/6	17	2	1	4	4	2	1	1	0	2	2	0	32	4	36
10/8	14	2	1	9	3	1	1	0	0	1	2	0	31	3	34
10/10	10	4	4	2	5	0	1	2	0	2	1	0	28	3	31
10/12	7	0	3	2	4	3	1	1	0	1	0	1	21	2	23

## Appendix C.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non- pup	Pup	Grand
10/14	15	2	2	4	7	1	1	1	0	2	2	1	33	5	38
10/16	9	1	4	4	4	2	1	1	0	1	0	0	31 <sup>a</sup>	1	32
10/18	11	2	1	7	6	4	0	1	0	2	3	0	32	5	37
10/20	12	6	1	8	5	2	0	2	0	2	1	1	36	4	40
10/22	7	2	1	6	6	3	0	0	0	0	0	0	38 <sup>a</sup>	0	38

<sup>a</sup>Total includes some seals that were not placed in any size class.

Appendix D.--Number of Hawaiian monk seals, by age class and sex, counted on censuses conducted at Shark Island, Kure Atoll, 1985. (M = male, F = female, and ? = unknown.)

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non-pup	Pup	Grand
1/30	1	0	0	0	1	0	1	0	0	0	0	0	3	0	3
2/5	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
2/17	1	0	0	0	1	0	0	0	0	0	0	0	2	0	2
2/23	2	0	2	0	1	0	2	0	0	0	0	0	7	0	7
3/13	1	0	0	1	1	0	1	0	1	0	0	0	5	0	5
3/17	2	0	1	1	0	1	0	0	0	0	0	0	5	0	5
3/21	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
4/2	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1
4/8	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1
4/10	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
4/30	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1
5/4	1	1	0	0	0	0	0	0	0	0	0	0	2	0	2
5/22	1	0	0	1	0	2	0	0	0	0	0	0	4	0	4
5/24	2	1	0	1	0	0	0	0	0	0	0	0	4	0	4
5/26	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1
5/28	2	0	0	2	0	0	0	0	0	0	0	0	4	0	4
5/30	1	1	1	0	0	0	0	0	1	0	0	0	4	0	4
6/1	4	0	0	0	0	1	0	0	0	0	0	0	5	0	5
6/3	2	0	0	1	1	0	0	0	0	0	0	0	4	0	4
6/5	1	0	0	0	1	1	1	0	0	0	0	0	4	0	4
6/7	1	0	0	1	1	0	0	0	0	0	0	0	3	0	3
6/9	0	0	0	0	1	0	1	0	0	0	0	0	2	0	2
6/13	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1
6/17	1	0	0	0	1	1	0	0	0	0	0	0	3	0	3
6/19	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
6/22	1	0	0	1	0	0	0	0	0	0	0	0	2	0	2
6/24	0	0	0	1	1	0	0	0	0	0	0	0	2	0	2
6/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/28	1	0	2	0	1	0	0	0	0	0	0	0	4	0	4
6/30	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1
7/2	1	0	0	0	0	0	1	0	0	0	0	0	2	0	2
7/4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/6	2	0	0	0	0	0	0	0	0	0	0	0	2	0	2
7/8	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
7/12	1	0	0	1	0	0	0	0	0	0	0	0	2	0	2
7/14	2	0	0	1	0	0	0	0	0	0	0	0	3	0	3
7/16	1	0	0	1	0	0	0	0	0	0	0	0	2	0	2
7/18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/20	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
7/22	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
7/24	1	1	0	0	0	0	0	0	0	0	0	0	2	0	2
7/26	1	0	1	1	0	0	0	0	0	0	0	0	3	0	3

## Appendix D.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non- pup	Pup	Grand
	7/28	3	0	0	1	0	0	0	0	0	0	0	0	4	0
7/30	2	0	0	0	1	0	0	1	0	0	0	0	4	0	4
8/1	2	1	1	0	0	1	0	0	0	0	0	0	5	0	5
8/3	1	1	0	1	0	1	1	0	0	0	0	0	5	0	5
8/5	2	2	0	0	0	0	0	0	0	0	0	0	4	0	4
8/7	1	2	0	0	0	0	0	0	0	0	0	0	3	0	3
8/9	3	0	0	1	0	0	0	0	0	0	0	0	4	0	4
8/13	1	0	0	0	0	2	0	0	0	0	0	0	3	0	3
8/15	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
8/17	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
8/18	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
8/20	1	0	0	0	0	0	0	1	0	0	0	0	2	0	2
8/24	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1
8/27	1	1	0	0	0	0	0	1	0	0	0	0	3	0	3
8/29	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
8/31	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
9/2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/4	1	0	1	0	0	0	0	1	0	0	0	0	3	0	3
9/6	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
9/8	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
9/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/12	3	0	0	0	0	0	0	0	0	0	0	0	3	0	3
9/14	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
9/16	2	0	0	2	2	0	1	0	0	0	0	0	7	0	7
9/18	2	0	0	0	1	0	0	0	0	0	0	0	3	0	3
9/21	3	0	0	0	0	0	0	0	0	0	0	0	3	0	3
9/24	1	1	3	0	1	2	0	0	1	0	0	0	9	0	9
9/26	2	1	3	2	1	1	0	1	0	0	0	0	11	0	11
9/28	1	0	1	1	0	0	0	0	0	0	0	0	3	0	3
9/30	1	1	1	0	0	0	0	0	0	0	0	0	3	0	3

Appendix E.--Number of Hawaiian monk seals, by age class and sex, counted on censuses conducted at Sand Island, Kure Atoll, 1985. (M = male, F = female, and ? = unknown.)

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non-pup	Pup	Grand
2/5	1	0	2	0	2	1	1	0	1	0	0	0	8	0	8
2/17	0	0	2	1	0	1	0	0	0	0	0	0	4	0	4
2/23	2	0	1	3	1	2	0	0	1	0	0	0	10	0	10
3/13	0	0	4	1	0	2	0	1	1	0	0	0	9	0	9
3/17	2	0	1	3	0	4	1	0	1	0	0	0	12	0	12
3/21	2	1	0	3	2	1	1	0	0	0	0	0	10	0	10
4/2	3	0	1	1	1	2	1	0	0	0	0	0	9	0	9
4/8	3	1	2	1	0	1	1	0	0	0	0	0	9	0	9
4/10	2	0	2	0	0	1	0	0	0	0	0	0	5	0	5
4/30	6	1	0	0	0	0	0	0	0	0	0	0	7	0	7
5/22	2	1	0	2	1	1	0	0	0	0	0	0	7	0	7
5/24	3	1	1	0	0	2	0	0	0	0	0	0	7	0	7
5/26	2	2	2	1	0	1	0	0	0	0	0	0	8	0	8
5/28	1	0	1	2	0	2	1	0	0	0	0	0	7	0	7
5/30	1	0	2	0	1	1	0	0	1	0	0	0	6	0	6
6/1	2	1	0	1	0	3	0	0	0	0	0	0	7	0	7
6/3	1	0	2	1	2	1	1	0	0	0	0	0	8	0	8
6/5	4	0	0	0	0	3	1	0	0	0	0	0	8	0	8
6/7	2	2	1	2	0	0	0	0	0	0	0	0	7	0	7
6/9	3	2	0	1	0	1	0	0	0	0	0	0	8	0	8
6/13	2	0	0	1	0	2	0	0	0	0	0	0	5	0	5
6/17	1	0	1	3	0	0	0	0	0	0	0	0	5	0	5
6/19	2	0	0	1	0	1	0	0	0	0	0	0	4	0	4
6/22	3	1	1	1	1	0	0	0	0	0	0	0	7	0	7
6/24	4	0	0	1	2	0	1	0	0	0	0	0	8	0	8
6/26	2	0	0	3	0	1	0	0	0	0	0	0	6	0	6
6/28	1	0	0	0	0	2	0	0	0	0	0	0	3	0	3
6/30	3	0	0	2	0	1	0	0	0	0	0	0	6	0	6
7/2	1	0	0	3	1	0	0	0	0	0	0	0	5	0	5
7/4	3	0	0	4	0	1	0	0	0	0	0	0	8	0	8
7/6	2	0	0	4	0	1	0	0	0	0	0	0	7	0	7
7/8	2	2	0	1	2	1	0	0	0	0	0	0	8	0	8
7/12	2	0	0	3	2	1	0	0	0	0	0	0	8	0	8
7/14	2	1	1	0	1	2	1	0	0	0	0	0	8	0	8
7/16	1	0	0	4	1	0	1	0	0	0	0	0	7	0	7
7/18	2	0	0	3	2	2	0	0	0	0	0	0	9	0	9
7/20	2	0	0	1	2	2	1	0	0	0	0	0	8	0	8
7/22	0	0	1	4	2	0	0	0	0	0	0	0	7	0	7
7/24	2	0	0	3	2	0	0	1	0	0	0	0	8	0	8
7/26	0	0	0	1	2	0	0	0	0	0	0	0	3	0	3
7/28	2	0	0	2	0	2	0	0	0	0	0	0	6	0	6
7/30	2	0	0	2	0	3	0	0	0	0	0	0	7	0	7

## Appendix E.--Continued.

Date	Adult			Subadult			Juvenile			Pup			Total		
	M	F	?	M	F	?	M	F	?	M	F	?	Non-pup	Pup	Grand
8/1	1	0	0	2	1	1	0	0	0	0	0	0	5	0	5
8/3	2	0	1	1	1	1	1	0	0	0	0	0	7	0	7
8/5	2	0	0	3	0	1	0	0	0	0	0	0	6	0	6
8/7	0	0	1	3	0	0	0	1	0	0	0	0	5	0	5
8/9	1	1	0	1	1	1	0	0	0	0	0	0	5	0	5
8/13	2	0	0	2	1	0	0	1	0	0	0	0	6	0	6
8/15	3	0	0	1	0	0	0	1	0	0	0	0	5	0	5
8/17	3	0	0	1	0	0	0	1	0	0	0	0	5	0	5
8/18	3	0	0	2	0	0	0	0	0	0	0	0	5	0	5
8/20	3	0	0	1	0	0	0	0	0	0	0	0	4	0	4
8/24	7	0	0	2	0	0	0	1	0	0	0	0	10	0	10
8/27	3	1	3	2	0	0	0	0	0	0	0	0	9	0	9
8/29	4	0	2	3	0	1	0	0	0	0	0	0	10	0	10
8/31	6	0	0	2	0	2	0	0	0	0	0	0	10	0	10
9/2	2	0	0	3	1	0	0	0	0	0	0	0	6	0	6
9/4	3	0	2	0	1	0	0	0	0	0	0	0	6	0	6
9/6	5	0	0	3	1	0	0	0	0	0	0	0	9	0	9
9/8	4	1	1	1	0	2	0	0	0	0	0	0	9	0	9
9/10	3	0	1	3	0	1	0	0	0	0	0	0	8	0	8
9/12	4	1	1	4	0	2	0	1	0	0	0	0	13	0	13
9/14	6	0	0	1	1	1	0	1	0	0	0	0	10	0	10
9/16	3	0	0	3	0	0	0	0	0	0	0	0	6	0	6
9/18	2	0	1	2	0	1	0	0	0	0	0	0	6	0	6
9/21	3	1	4	3	0	3	0	0	0	0	0	0	14	0	14
9/24	2	0	3	1	0	0	0	0	0	0	0	0	6	0	6
9/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/28	3	0	2	2	1	1	1	0	0	0	0	0	10	0	10
9/30	8	1	2	2	0	0	1	1	0	0	1	0	15	1	16

Appendix F.--Summary of sector use by Hawaiian monk seals for whole atoll censuses at Kure Atoll, 1985, depicted as averages for each size class and sex. (M = male, F = female, ? = unknown.)

Sector	Adult			Subadult			Juvenile			Pup			Total
	M	F	?	M	F	?	M	F	?	M	F	?	
1	0.4	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
2	2.2	0.5	0.6	0.6	0.4	0.3	0.2	0.4	0.0	0.6	0.0	0.0	5.9
3	1.0	0.2	0.2	0.2	0.3	0.2	0.0	0.0	0.0	0.4	0.0	0.0	2.3
4	0.6	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
5	1.0	0.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.1	0.0	0.0	2.1
6	1.2	0.1	0.3	0.4	0.3	0.2	0.2	0.0	0.0	0.2	0.2	0.0	3.4 <sup>a</sup>
7	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.7
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
9	0.9	0.2	0.3	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	2.3
10	2.2	0.2	0.7	1.6	0.5	0.9	0.2	0.1	0.0	0.0	0.0	0.0	6.4
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.8	0.0	1.2
Total	9.7	2.0	2.6	3.5	2.7	2.0	0.9	0.7	0.2	1.4	1.3	0.0	27.3

<sup>a</sup>Total includes some seals that were not placed in any size class or sex.

## Appendix G.--Itinerary for captive maintenance program at Kure Atoll, 1985.

Date	Event
3/11-26	Enclosure is constructed at Kure Atoll for captive maintenance program. Upon its completion, fishing is begun to stock the enclosure with live reef fish.
5/3	First female monk seal pup is placed in the ocean-beach enclosure.
6/1	Second female monk seal pup is added to the ocean-beach enclosure. Both seals eating by end of month.
6/21	Three female Hawaiian monk seal yearlings from French Frigate Shoals are brought to Kure Atoll via U.S. Coast Guard C-130 and placed in the ocean-beach enclosure with the two Kure pups.
8/26-27	French Frigate Shoals' yearlings are released.
8/28	The third Kure-born female monk seal pup is placed in the ocean-beach enclosure.
9/20	Storm weakens pen and pups are released. Scheduled release was to be 22 September, but because of dangerous pen conditions, pups are released early.
9/22	Pup (ID No. K517) is the victim of entanglement incident (see Table 6).
9/23- 10/23	All three Kure Atoll female pups and three French Frigate Shoals yearlings are resighted many times and appear to be in good health.

## Appendix H.--Monk seal necropsy reports, Kure Atoll, 1985.

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NECROPSY NO. : 01MSK85  
DATE OF DEATH: 21-23 February  
DATE AND TIME  
OF NECROPSY: 23 February, 1700-1900  
SEX: Male

AGE: Aged between 24 and 27 years old by using tooth aging (for technique see Kenyon and Fiscus (1963) and Pierce and Kajimura (1980))

CIRCUMSTANCES OF DEATH: Cause of death unknown. Seal was seen alive on North Point of Green Island on 21 February 1985, at which time his emaciated condition was noted and photos taken. On 23 February 1985 at approximately 1330, an adult monk seal was seen attempting to copulate with the lifeless body of a seal that, upon retrieval, was found to be the seal seen on 21 February.

EXTERNAL DESCRIPTION: Body rigid. No external wounds. No pelage slippage or fly larvae.

Measurements: Length--230 cm  
Girth--111 cm  
Blubber thickness at sternum and abdomen--1.2 cm

INTERNAL: Front teeth worn and yellowed. Esophagus contained nematodes. Stomach had a heavy parasite load, some attached. Skull intact.

SAMPLES COLLECTED: Major organs sampled but lost in shipment.

PATHOLOGIST: G. N. Stemmerman, M. D., Department of Pathology,  
Kuakini Medical Center, Honolulu, Hawaii 96817.

## Appendix H.--Continued.

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NECROPSY NO. : 02MSK85      ID = K511 (yellow tag)  
 DATE OF DEATH: Probably 7 or 8 April  
 DATE AND TIME  
   OF NECROPSY: 8 April, 1615-1830  
 SEX:            Male

AGE: This was a yearling transferred from French Frigate Shoals

CIRCUMSTANCE OF DEATH: Unknown. Since February 1985, his small size was noted and periodic photographs taken. On an unrecorded date in mid-March, he was heard emitting congested noises. He was often seen hauled up near large objects, shivering. During the census on 8 April, he was found dead on Stark reef.

EXTERNAL DESCRIPTION: No external wounds, pelage slippage, or fly larvae. Body not rigid.

Measurements: Not taken.

INTERNAL: Froth found just before bifurcation of trachea and into bronchioles of both lungs. Bruising of the upper small intestine; photographed and bladder sampled approximately 0.237 L full. Skull intact.

SAMPLES COLLECTED: Kidney, liver, lungs, lymph nodes, pancreas, skull, small bowel, and stomach.

PATHOLOGY REPORT: Significant pathologic findings in this animal include severe gastric autolysis and chronic nematode-induced ulceration. Nematodes found embedded in the base of the ulcer were surrounded by dense aggregates of bacteria. There was nodal lymphocyte depletion suggesting chronic disease. The historical information of poor growth from the time of premature weaning substantiates chronic disease.

The marked congestion found histologically in the liver, lungs, and kidney would suggest heart failure as the immediate cause of death. The primary etiology cannot be accurately determined from available data.

PATHOLOGIST: G. N. Stemmerman, M. D., Department of Pathology,  
 Kuakini Medical Center, Honolulu, Hawaii 96817.

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